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Title of Application:

METHOD AND SYSTEM FOR DISTRIBUTED AUTONOMOUS MAINTENANCE OF BIDIRECTIONAL HYPERLINK METADATA ON THE WEB AND SIMILAR HYPERMEDIA REPOSITORY

Transmitted with the patent application are the following:

<u>2</u>	Page(s)	Transmittal form (and one copy)
<u>17</u>	Page(s)	Specification, claims, abstract
<u>3</u>	Page(s)	Formal Drawings
<u>3</u>	Page(s)	An unsigned Declaration and Power of Attorney
<u>1</u>	Page(s)	Information Disclosure Statement
<u>1</u>	Page(s)	PTO-Form 1449
<u>4</u>		References

This application is a: ☐ Continuation ☐ Divisional ☐ Continuation-in-Part of prior application Serial No. _____

Fee Calculation

	Claims Filed		Extra	Rate	Fees
Basic Fee					\$690.00
Total Claims	16	- 20 =	0	× \$18.00	.00
Independent Claims	4	- 3 =	1	× \$78.00	78.00
Multiple Dependent Claim				+ \$260.00	
				Assignment	\$40.00
				TOTAL	\$808.00

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METHOD AND SYSTEM FOR DISTRIBUTED AUTONOMOUS MAINTENANCE OF BIDIRECTIONAL HYPERLINK METADATA ON THE WEB AND SIMILAR HYPERMEDIA REPOSITORY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to searching wide area computer networks for information, and more particularly to searching the World Wide Web for topical information.

2. Description of the Related Art

The wide area computer network known as the "World Wide Web", or simply "Web", contains a vast amount of information in the form of Web pages. Each Web page is electronically stored in a respective Web site on a computer, referred to as a Web server, with the Web itself including many Web servers that are interconnected by means of the Internet. A person can connect a computer to the Internet via, e.g., a telephone line, and thereby electronically access the Web pages on the Web servers.

As the Web has grown, many millions of Web pages have been created. In other words, the Web contains a vast amount of information, and the content of the Web grows and changes minute by minute. It will accordingly be appreciated that some means must be provided for a person to sort through the vast quantities of Web pages to find a particular item of interest.

With the above consideration in mind, most users employ software known as Web browsers when accessing the Web. To search the Web for a particular topic of information, the user causes their Web browser to access a Web site of a centralized search engine that is maintained by a search company. Examples of currently popular search engines are Alta Vista™ and Hotbot™.

Centralized search engines use software referred to as "crawlers" to continuously access Web pages and log and categorize the pages in a centralized index. When a person wishes to retrieve information, the person's browser accesses a centralized search engine using a query, for example, "luxury cars". In response, software at the centralized engine accesses its index to retrieve names of Web sites considered by the search engine to be appropriate sources for the sought-after information. The search engine transmits to the browser hyperlinks to the retrieved sites, along with brief summaries of each site, with the browser presenting the information to the user. The user can then select the site or sites they want by causing the browser to access the site or sites.

Owing to the burgeoning of the Web and the ever-growing amount of its information, and the fact that the above-described centralized crawler schemes posture themselves to respond to any possible query (i.e., to be all things to all people), centralized crawler/searchers require large investments in hardware and software and must never cease crawling the Web, to index new pages and to periodically revisit old pages that might have changed. Indeed, one Web search company currently requires the use of 16 of the most powerful computers made by a major computer manufacturer, each computer having 8 gigabytes of memory. Another search company currently uses a cluster of 300 powerful workstations and over one terabyte of memory to crawl over 10 million Web pages per day. Despite these heroic efforts, however, it is estimated that a single search company is able to index only 30%-40% of the Web, owing to the size of the Web which, incidentally, shows no signs of slowing its rate of expansion.

Accordingly, one problem with current technology that is recognized and addressed by the present invention is the need to reduce the vast amount of Web search hardware and software that is inherently required by a centralized search scheme.

Additionally, evaluating whether a particular Web page contains relevant information with respect to a user query is sometimes difficult. Moreover, user queries may not be effectively articulated, or they may be overbroad. Consequently, a Web search engine frequently responds to a query by returning a large number of Web pages that are of little or no interest to the requester. Nonetheless, a user must laboriously sort through hundreds and perhaps thousands of returned Web pages, which, as discussed above, can be considered to represent only 30%-40% of the total Web content in any case. Moreover, because a centralized crawler seeks the capability to respond to any query, most of the index of any single centralized system contains information that is of little or no value to any single user or indeed to any single interrelated group of users.

Thus, two other problems recognized and addressed by the present invention are the lack of focus of search results, and the fact that centralized crawlers are not tailored to any particular user or to any particular interrelated group of users and, thus, contain mostly irrelevant information, from the point of view of a single user or group of users.

In addition to the above considerations, the present invention recognizes that many if not most Web pages refer to other Web pages by means of hyperlinks, which a user can select to move from a source Web page to a target Web page. The present invention further recognizes that such hyperlinks are more than simply navigation tools; they are important categorization tools as well. More specifically, a particularly "good" page on a certain topic might be referred to by a large number of other pages, and thus the number of referrals (referred to as "inlinks") to a Web page is an indication of its effectiveness.

It happens that with the existing Web communication protocol (hypertext transfer protocol, or "http"), when a user clicks on a hyperlink to a target Web page v from a source Web page u , the

intended herein, each sibling link is an outlink of one of the inlinks in the table, and the sibling links can be searched for information that is relevant to the Web page associated with the inlink table.

In a preferred embodiment, the user logic means includes means for downloading the table from the Web server to the user computer. Each inlink on the table is a hyperlink to a respective Web site, such that a person operating the user computer can select one of the inlinks to download the Web site associated with the selected inlink. Alternatively, the user logic means can include means for downloading the table from the Web server to the user computer, and means for automatically accessing the inlinks to search the inlinks for predetermined information, i.e., information that is relevant to a predefined topic.

In the preferred embodiment of the present invention, a data storage device stores at least portions of the inlink table. Means at the Web server prune inlinks in the table in response to at least one preselected criterium, such as a number of selections of each inlink, so that the table fits within the capacity of the data storage device.

In another aspect, a computer-implemented method is disclosed for accumulating information on the World Wide Web that is relevant to at least one topic. The method includes generating a list of inlinks at a Web server for at least one Web page associated with the server, and, at a user computer, downloading the list of inlinks for facilitating information retrieval using the list.

In still another aspect, a computer program device includes a computer program storage device readable by a user computer and a program on the program storage device. The program includes instructions that are executable by the user computer for performing method steps for searching the World Wide Web. The method steps include downloading a Web page from a Web server and requesting an inlinks or backlinks list associated with the Web page. Also, the method steps required

by the program include receiving from the Web server the list of inlinks or backlinks to the Web page, in response to the requesting step.

In still another aspect, a computer program device includes a computer program storage device readable by a Web server and a program on the program storage device. The program includes instructions executable by the Web server for performing method steps for compiling information useful for searching the World Wide Web. The method steps include receiving hyperlink requests for Web pages, with each hyperlink request being sent from an inlink. Also, the method steps include recording at least some inlinks along with one or more inlink criteria, and then transmitting the inlinks to user computers that request the inlinks.

The details of the present invention, both as to its structure and operation, can best be understood in reference to the accompanying drawings, in which like reference numerals refer to like parts, and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of the present system;

Figure 2 is a schematic diagram of a computer program device or product;

Figure 3 is a flow chart of the overall logic;

Figure 4 is a flow chart of the manual search logic;

Figure 5 is a diagram of an inlinks table and sibling link table; and

Figure 6 is a flow chart of the automatic search logic.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to Figure 1, a system for effective World Wide Web information searching is shown, generally designated 10. In the particular architecture shown, the system 10 includes a digital processing apparatus, such as at least one user computer 12. In one intended embodiment, the user computer 12 may be a personal computer made by International Business Machines Corporation (IBM) of Armonk, N.Y. as shown, or the user computer 12 may be any computer, including computers sold under trademarks such as AS400, with accompanying IBM Network Stations. Or, the user computer 12 may be a Unix computer, or OS/2 server, or Windows NT server, or IBM RS/6000 250 workstation with 128 MB of main memory running AIX 3.2.5., or an IBM laptop computer.

The user computer 12 includes a JAVA enabled computer network browser 14 and an inlink request applet 16 which may be executed by a processor within the computer 12 as a series of computer-executable instructions. These instructions may reside, for example, in RAM of the computer 12.

Alternatively, the instructions may be contained on a data storage device with a computer readable medium, such as a computer diskette 18 shown in Figure 2 and having a computer readable medium 20 with program code elements A-D thereon. Or, the instructions may be stored on a DASD array, magnetic tape, conventional hard disk drive, electronic read-only memory, optical storage device, or other appropriate data storage device. In an illustrative embodiment of the invention, the computer-executable instructions may be lines of compiled C++ compatible code. In any case, it is to be understood that the flow charts show the function of the logic undertaken by the applet 16.

Figure 1 also shows that the system 10 can include peripheral computer equipment known in the art, including one or more output devices 22 such as a video monitor and one or more input devices 24 such as a computer keyboard. Other output devices can be used, such as printers, other computers, and so on. Likewise, input devices other than a keyboard can be used, e.g., a mouse, or trackballs, keypads, touch screens, and voice recognition devices. Also, a topic analyzer 26, such as the topic analyzer disclosed in co-pending U.S. patent application serial no. _____, filed _____, incorporated herein by reference and owned by the present assignee, can be accessible to the user computer 12.

In accordance with principles known in the art, the user computer 12 can use a Web browser interface (WBI) proxy 28 to communicate via the Internet 30 with one or more Web servers 32. In one preferred embodiment, the Web server 32 uses Apache® hypertext transfer protocol (http). The Web server 32 includes one or more Web pages 34, depicted in Figure 1 as being portions of a Web page database, for sending a Web page to a user computer 12 upon user request.

Additionally, the Web server 32 includes a backwards browsing module 36 that functions in accordance with logic shown in the accompanying flow charts. The backwards browsing module 36 accesses a small (e.g., about five megabytes) inlink or backlink database 38. If desired, the user computer 12 can access other services 40, including conventional Web search services such as Hotbot®, via the Internet 30.

Now referring to Figure 3, at block 42 for each Web page 34 accessed via a hyperlink to that page, the Web server 32 enters a "DO" loop to undertake the following. As recognized by the present invention, when a user hyperlinks to a target page from a source page, the identity of the source page is recorded by the Web server of the target page. Accordingly, the Web server 32

proceeds to block 44 to record the inlink (i.e., the identity of the source page from which the user is being linked) in a list, preferably a table, for the Web page being linked to (the target page). The list or table is a map between uniform resource locators (URLs) of Web pages and their associated integer identifications. Also, the time the target page was accessed is recorded, and a counter associated with the inlink is incremented by unity each time the target Web page is accessed from that source page. As used herein, the terms "inlink" and "backlink" interchangeably mean a hyperlink on a source Web page that a user can "click" on using, e.g., a mouse, to download a target Web page.

One exemplary data structure generated at block 44 is:

from_ID, to_ID, Num_Clicks, Last_Click_Time, wherein

from_ID is the source page, *to_ID* is the target page being linked to, *Num_Clicks* is the number of times users have accessed the target page from the source page, and *Last_Click_Time* is the date and time of the most recent access of the target page from the associated source page.

From block 44 the logic proceeds to block 46 to store the inlinks in the backlink database 38. Next, proceeding to block 48 the list or table of inlinks can be pruned in accordance with one or more predetermined criteria to conform to the relatively small size of the backlink table 38. For example, inlink table records with *Last_Click_Times* earlier than a predetermined aged time, or with a *Num_Clicks* entry smaller than a predetermined integer, or some combination of the above two

criteria, can be pruned from the inlinks table at block 48. As described in detail below, the process can then move to block 50 to mine the inlink table of a Web page for sibling links, i.e., outlinks of inlink entries in the inlinks table.

Figures 4-6 show example details of the mining that can occur at block 50 in Figure 3. At block 52 in Figure 4, for instance, a user can generate a query for inlinks by appropriately manipulating the input device 24 (Figure 1) to download, at block 54, the inlinks list from the Web server 32 of a Web page 34. Referring to Figure 5, the query can be generated by, e.g., clicking on an inlink or backlink button 56 on a screen display 58 of the Web page as presented on the output device 22 of the user computer 12. The displays shown in Figure 5 are actual screen displays generated by an encoded version of the present invention. By clicking on the inlink or backlink button 56, the user can generate a new type of http request having, as one example, the syntax *INLINK /photo/edscott/spectsel.htm HTTP/1.0* (wherein the name of the Web server in the exemplar is "www.photo.net").

In response, an inlinks or backlinks list 60 containing plain text names of inlinks 62 from a Web page 34 (in the example shown, "DECCAN HERALD") is presented to the user. A variety of simple reply formats can be provided, such as:

```
<html>
<ahref="http://www.yahoo.com/Arts/Photography/Infrared/">15.894046903</a><br>
<ahref="http://www.infoseek.com/Recreation/Photography/">6.894046903</a><br>
</html>
```

In the above examples, the first number is the number of clicks ("Num_Clicks") and the second is the latest click time ("Last_Click_Time") for that link at the server, with the remaining data

indicating the name of the inlink. Such a response can be readily parsed or viewed at the user computer 12 by the browser 14.

Moving to block 64 of Figure 4 and still referring to Figure 5, a user can click on one of the inlinks (in the example shown, "NEWSPAPERS, INDIA") to access the Web page 34 associated with the inlink and, more particularly, to be presented with a list 65 of outlinks 66 from the inlink page. These outlinks are sibling links to the web page 34 associated with the inlink list 60. As understood herein, the sibling links can be expected to be relevant to the web page associated with the inlink list 60.

The above process can be automated if desired. For example, referring now to Figure 6, at block 68 the Web server 32 can receive a query for Web pages from a Web crawler, e.g., the crawler disclosed in our co-pending U.S. patent application serial no. 09/239,921, owned by the same assignee as the present invention and incorporated herein by reference. The crawler can be associated with the user computer 12, and an inlink table would thus be returned to the user computer 12. At block 70, the crawler could test each inlink serialtim for relevancy to a predefined topic using the topic analyzer 26 (Figure 1) and also find the outlinks to each inlink. Moving to block 72, the outlinks likewise can be tested for relevancy to a predefined topic. Thus, the process shown in Figure 6 is essentially a backwards crawling process.

In one preferred embodiment, the crawler can undertake the above steps by running a CGI program that prints out a sequence of sections. Each section title (in <h1>, for example) is a URL and the section consists of lines as above. It is also possible to add a non-text interface for efficiency, in which case the transmission format of the database would require standardization as

a new MIME type, for example, *application/inlink-table*. The new request, in one example, might look like:

5 *INLINK/photo/edscott/spectsel.htm HTTP/1.0*
 accept: application/inlink-table
 accept: text/html
 accept: text/plain

10 While the particular METHOD AND SYSTEM FOR DISTRIBUTED AUTONOMOUS
MAINTENANCE OF BIDIRECTIONAL HYPERLINK METADATA ON THE WEB AND
SIMILAR HYPERMEDIA REPOSITORY as herein shown and described in detail is fully capable
of attaining the above-described objects of the invention, it is to be understood that it is the presently
preferred embodiment of the present invention and is thus representative of the subject matter which
is broadly contemplated by the present invention, that the scope of the present invention fully
encompasses other embodiments which may become obvious to those skilled in the art, and that the
scope of the present invention is accordingly to be limited by nothing other than the appended claims.

15 WE CLAIM:

CLAIMS

1 1. A computer system, comprising:
2 at least one user computer;
3 a data input device associated with the user computer;
4 a Web server communicating with the user computer;
5 server logic means at the Web server for generating a table of inlinks to at least one
6 Web page associated with the Web server; and
7 user logic means at the user computer for accessing the table of inlinks to facilitate
8 generating a list of sibling links based on the table, each sibling link being an outlink of one
9 of the inlinks in the table, for accessing the sibling links.

1 2. The system of Claim 1, wherein the user logic means includes means for downloading
2 the table from the Web server to the user computer, each inlink on the table being a hyperlink to a
3 respective Web site, such that a person operating the user computer can select one of the inlinks to
4 invoke the Web site associated with the selected inlink.

1 3. The system of Claim 1, wherein the user logic means includes:
2 means for downloading the table from the Web server to the user computer; and
3 means for automatically accessing the inlinks to search the inlinks for predetermined
4 information.

1 4. The system of Claim 1, further comprising a data storage device for storing at least
2 portions of the table.

1 5. The system of Claim 4, further comprising means at the Web server for pruning
2 inlinks in the table in response to at least one preselected criterium.

1 6. The system of Claim 5, wherein the preselected criterium is based at least in part on
2 a number of selections of each inlink.

1 7. A computer-implemented method for accumulating information on the World Wide
2 Web that is relevant to at least one topic, comprising the steps of:

3 at a Web server, generating a list of inlinks for at least one Web page associated with
4 the server; and

5 at a user computer, downloading the list of inlinks for facilitating information retrieval
6 using the list.

1 8. The method of Claim 7, wherein the list is a table, and the method includes generating
2 a list of sibling links based on the table, each sibling link being an outlink of one of the inlinks in
3 the table, for searching the sibling links.

1 9. The method of Claim 8, further including downloading the table from the Web server
2 to the user computer, each inlink on the table being a hyperlink to a respective Web site, such that

3 a person operating the user computer can select one of the inlinks to invoke the Web site associated
4 with the selected inlink.

1 10. The method of Claim 8, further comprising:
2 downloading the table from the Web server to the user computer; and
3 automatically accessing the inlinks to search the inlinks for predetermined information.

1 11. The method of Claim 8, further comprising pruning inlinks in the table in response
2 to at least one preselected criterium.

1 12. The method of Claim 11, wherein the preselected criterium is based at least in part
2 on a number of selections of each inlink.

1 13. A computer program device comprising:
2 a computer program storage device readable by a user computer; and
3 a program means on the program storage device and including instructions executable by the
4 user computer for performing method steps for searching the World Wide Web, the method steps
5 comprising:

6 downloading a Web page from a Web server;
7 requesting an inlinks or backlinks list associated with the Web page; and
8 in response to the requesting step, receiving from the Web server the list of inlinks
9 or backlinks to the Web page.

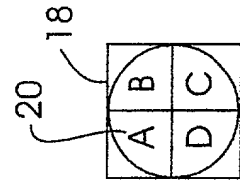
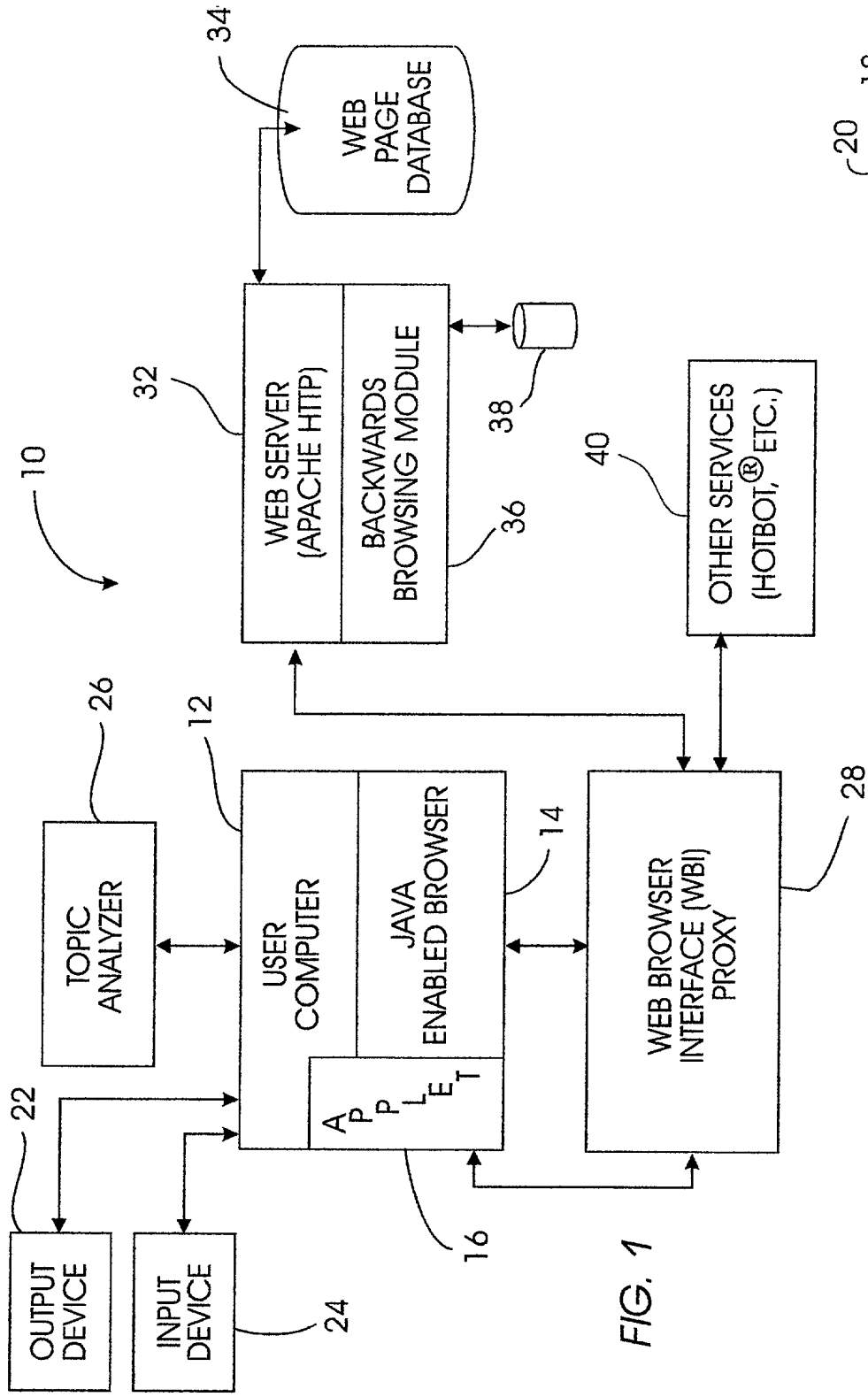
1 14. The computer program device of Claim 13, wherein the method steps further comprise:
2 automatically accessing the list to obtain sibling links to the Web page.

1 15. A computer program device comprising:
2 a computer program storage device readable by a Web server; and
3 a program means on the program storage device and including instructions executable by the
4 Web server for performing method steps for compiling information useful for searching the World
5 Wide Web, the method steps comprising:
6 receiving hyperlink requests for Web pages, each hyperlink request being sent via an
7 inlink;
8 recording at least some inlinks along with one or more inlink criteria; and
9 transmitting the inlinks to user computers requesting the inlinks.

1 16. The computer program device of Claim 15, wherein the inlink criteria include one or
2 more of: inlink request time, and number of times each inlink is used to hyperlink a user computer
3 to a Web page.

ABSTRACT OF THE DISCLOSURE

SECRET



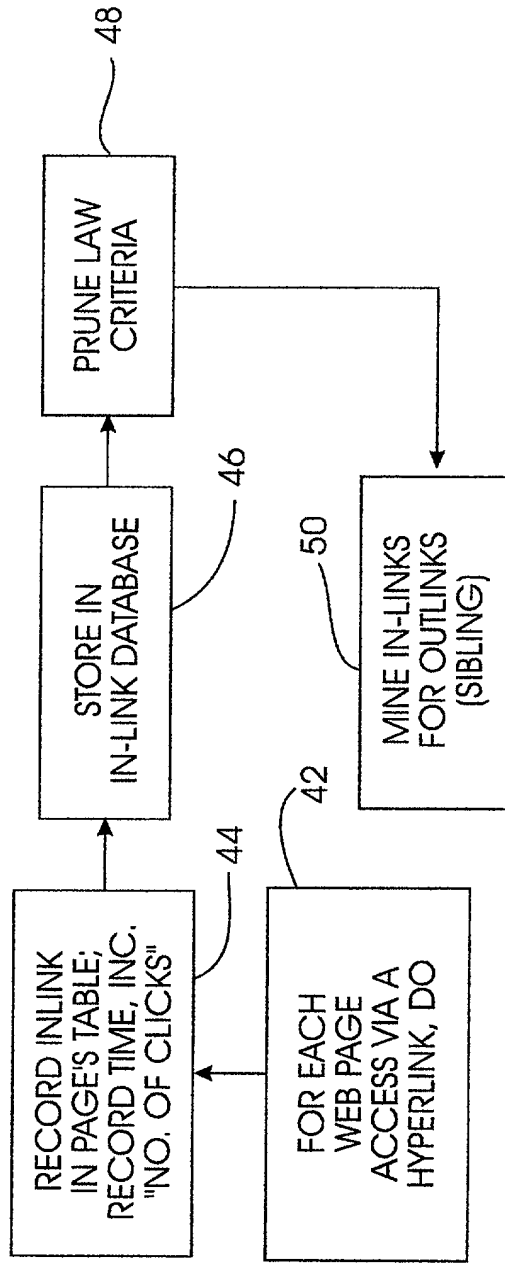


FIG. 4
(MANUAL-
INTERACTIVE)

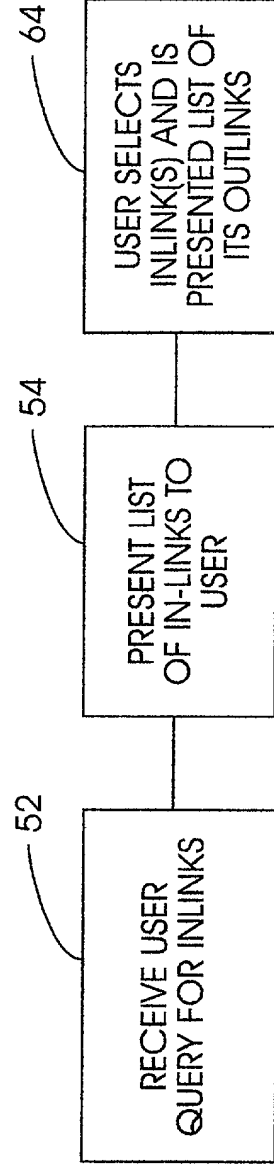
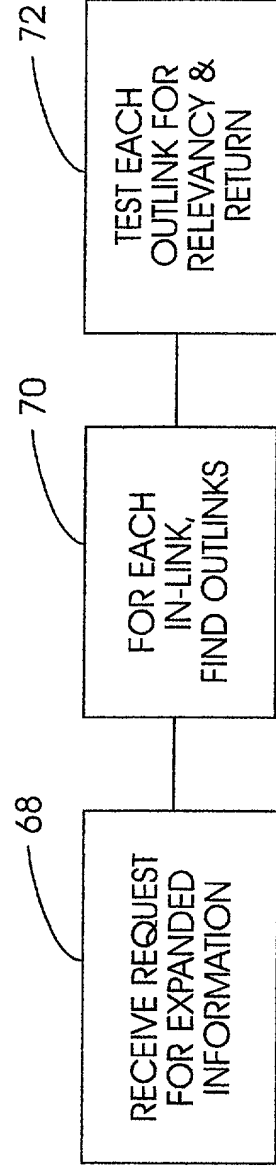


FIG. 6
(AUTOMATIC)



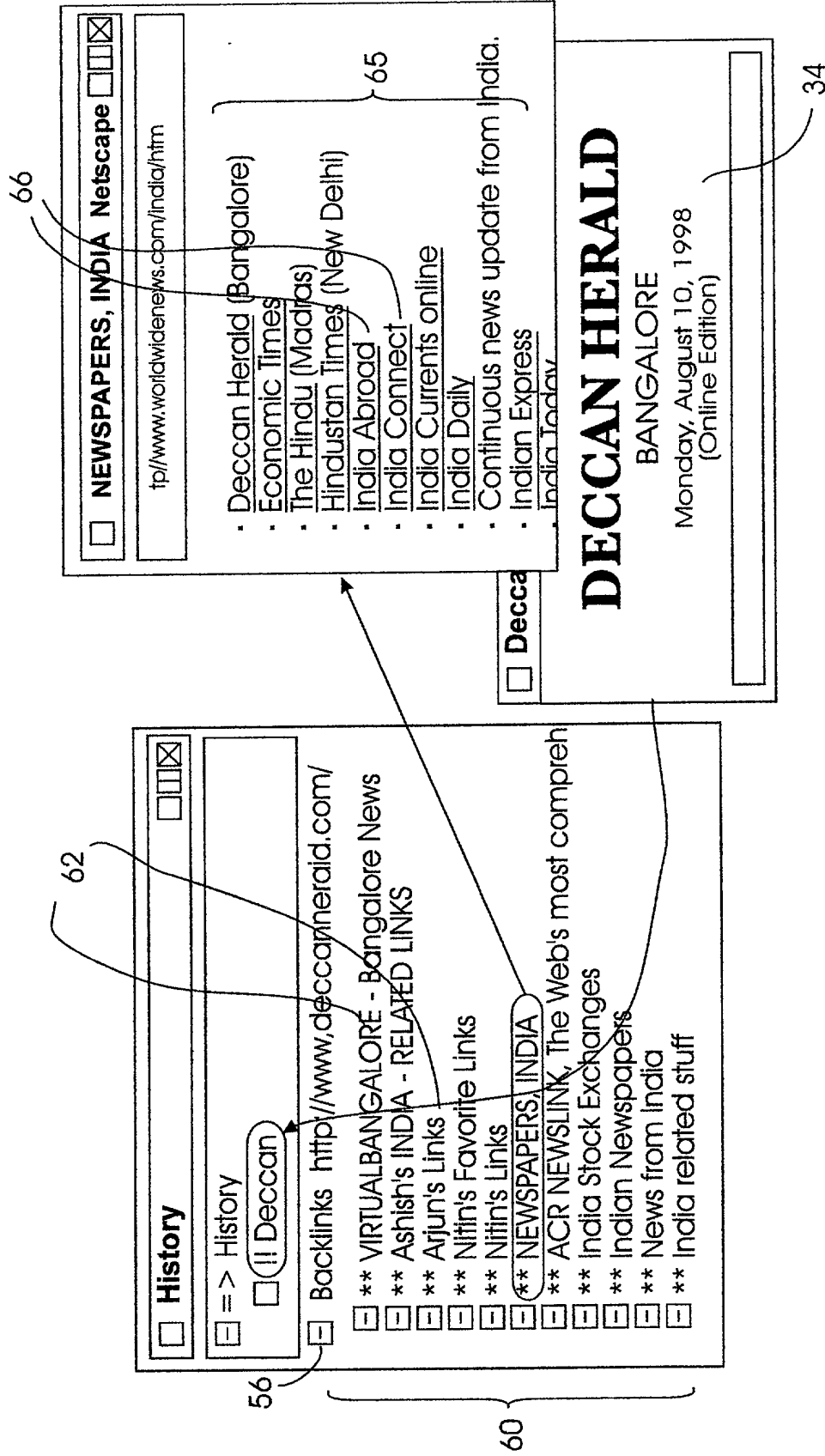


FIG. 5

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**METHOD AND SYSTEM FOR DISTRIBUTED AUTONOMOUS MAINTENANCE OF
BIDIRECTIONAL HYPERLINK METADATA ON THE WEB AND SIMILAR HYPERMEDIA
REPOSITORY**

the specification of which is attached hereto unless the following box is checked:

was filed on _____

as United States Application Number or PCT International Application Number _____

and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 USC §119(a-d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s):**Priority Not Claimed**

(Number)

(Country)

(Day/Month/Year Filed)

I hereby claim the benefit under 35 USC §119(e) of any United States provisional application(s) listed below:

Provisional Application(s):

(Application Number)

(Filing Date)

I hereby claim the benefit under 35 USC §120 of any United States application(s), or §365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 USC §112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application Number)

(Filing Date)

(Status - patented, pending, abandoned)

Power of Attorney:

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor:**Soumen Chakrabarti****Inventor's signature:****Date:****Residence:** CTR-130, Indian Institute of Technology Bombay, Powai, Maharashtra India 400076**Citizenship:** India**Post Office Address:** Same**Full name of second inventor:** Byron Edward Dom**Inventors Signature:****Date:****Residence:** 111 Sebastian Court, Los Gatos, California 95032**Citizenship:** United States**Post Office Address:** Same**Full name of third inventor:** David Andrew Gibson**Inventor's signature:****Date:****Residence:** 2672 Hilgard Avenue, Berkeley, California 94709**Citizenship:** South Africa**Post Office Address:** Same

Inventor's signature:

Date:

Citizenship: United States

Post Office Address: Same

Inventor's signature:

Date:

Citizenship: The Netherlands

Post Office Address: Same

1. The first group of people who are interested in the study of the history of the United States are the people who are interested in the history of the United States.